Open Source QA - What will it take to get to the next level?

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Problem

- We can do better with Linux QA, as an industry and community

~~Problem~~ Opportunity

- We can do better with Linux QA, as an industry and community
- Not saying we're doing something wrong
  - Lots of great projects and efforts
- I think that we're missing opportunities to do better

Outline

Attributes of Open Source
Status of Open Source QA
Obstacles to Sharing
Solutions and Next Steps

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Attributes of Open Source

- Openly available
- Easy to contribute to
- Generalized
  - Applies to a broad range of uses
- Has a development community
- Community effect
  - Build on the work of others
  - As contributor pool increases, better ideas are found
  - Feedback loops
- The essence of Open Source is “exchange” or sharing

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Obstacles to Sharing

Solutions and Next Steps

Status of Open Source QA

- Software Landscape
  - Tools
  - Tests
- Hardware
- Industry QA efforts
  - In-house
  - Ad-hoc solutions
- Result = lots of unshared stuff

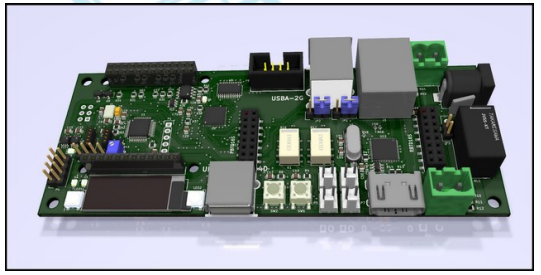
What tools in QA are Open Source

- Systems:
  - Buildbot, Jenkins, LAVA, LKFT, Fuego, KernelCI, CKI
- Lab/board management: Labgrid, SLAV, libvirt, r4d
- Harnesses: pytest, ptest (Yocto Project), ktest
- Services: 0-day, Phoronix, CKI?
- Tests suites: LTP, kselftest
- Tests
  - See next page

Open Source tests

- kernel testing
  - LTP – actually multiple test suites
  - sysbench, unixbench, hackbench, dhrystone, etc.
- system testing:
  - lsb-test, yocto ptest, debian autopkgtest
- filesystem – iozone, xfstest, bonnie, dbench
- realtime – cyclictest, pitest
- network – iperf, netperf
- security – vuls
- vertical tests – Android Compatibility Test Suite (CTS)?

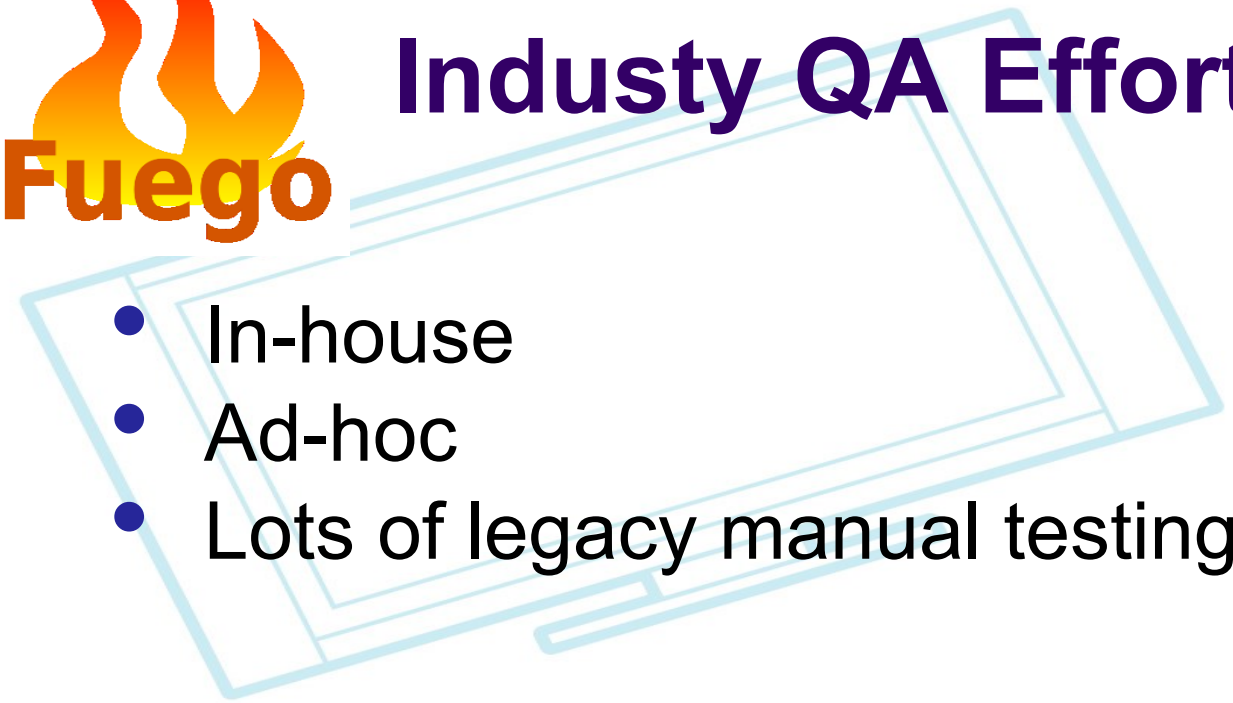
Test hardware



- Some off-the shelf components:
  - PDUs (power distribution units)
  - Commercial multi-boards: ACME
  - Video capture: Numato Opsis, Lenking LKV373a HDMI extender
- Some open hardware:
  - Multiboards: ACME, MuxPi, Sony debug board
  - Analyzers: Sigrok-based boards (eg. BeagleLogic)
- Different labs use different combinations of things
  - Often manually manage the hardware
- Companies have lots of in-house custom hardware solutions
  - e.g. Sony debug board has custom USB switching capability

Industy QA Efforts

- In-house
- Ad-hoc
- Lots of legacy manual testing



Unshared

- Many QA artifacts are not even tangible
  - Knowledge specific to the QA objectives
    - What tests to run?
    - Dependencies
    - Expected values – How to interpret results?
    - What metrics are important?
- Hardware testing is extremely silo-ed
- Exceptions:
  - Vendor-provided: Android compliance testing (CTS)

An analogy:

Today's QA software = Yesterday's RTOS

Embedded OS landscape 20 years ago

- Fragmented
- In-house
- Ad-hoc
- Unshared
- Some exceptions:
  - Commercial offerings: VxWorks, pSOS
  - Regional industry standard: µItron
  - Some open source solutions: mbed, ecos, etc.

Open Source Software vs. Testing

- Samsung, LG, Sony all produce TV sets
- 80% of software stacks in TVs are Open Source
- What percentage of QA software is Open Source?
- Which of these companies:
  - Contribute to Open Source test projects?
  - Share their TV functionality tests?

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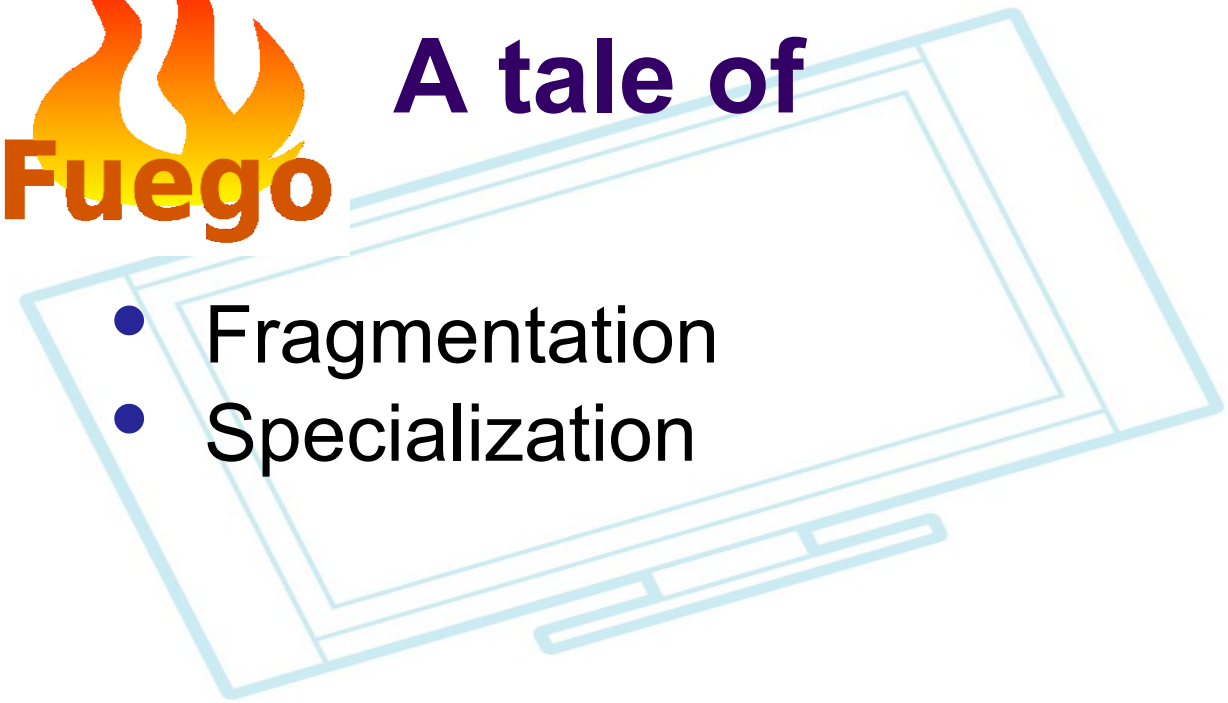
Silos... Why did it have to be silos...?

A tale of Fuego

- Fragmentation
- Specialization



It’s worse than just silos; The silos are all different

Obstacles to sharing

- Fragmentation
- Custom hardware
- Unique lab configurations
- Dependency on test framework (different APIs)
- Unique software
- Different testing goals
- Organizational inertia
- Licensing

Fragmentation of Test hardware API

- No consistent API for lab hardware with similar functionality
- Example: PDUs
  - There are many different ways to control power to a board in a lab
    - Serial-controlled power devices
      - APC devices, YKush, ...
    - Network-controlled power switches
      - Digital Loggers web power switch, Devantech devices
      - Custom-built network relays
    - USB-controlled power devices
      - Sony debug board, PowerUSB, etc.
- No single API for all of them

Specialization: Lab configuration

- Even with off-the-shelf hardware, labs use different hardware
  - Everyone seems to have a different PDU (Power Distribution Unit)
  - Different external power measurement devices
- Labs mix-and-match equipment
- Each lab ends up with unique combinations
- Tests written for one lab don't work in another

Specialization: Test Framework

- Different test frameworks have different APIs, test models

	Fuego	LAVA	Yocto Project
test driven from	host	target	target
target lifecycle	multiple tests per boot	re-provision every test	n/a
languages	host: bash, python, yaml, json target: sh	sh, awk, yaml	python
APIs	*X*	*Y*	*Z*
dependencies	permission, kconfig, mem, storage	permission, packages	packages

Specialization: Unique software

- Vendors have different software stacks above their Open Source layers
  - e.g. Samsung's TV stack doesn't look like Sony's TV stack
- More and more software is open source, and therefore common
  - Estimate is that for many products, 80% of the software is Open Source
- Lots of legacy test software
- Target distribution may have different installed software
  - e.g. may or may not have 'expect', 'awk', 'sed', or even 'grep'.

Fragmentation: Different test goals

- Developers and testers with different roles:
  - System software developers (Kernel developers)
  - Distribution developers (e.g. AGL, Android, CIP, other stacks)
  - Product developers (hardware/software integrators)
- Testing to:
  - Find software regressions
  - Find integration problems
  - Meet criteria for shipping
- Interested in different parts of the system
- Different threshold of sensitivity to bugs
- Focus on local remediation vs. upstream reporting and fixing

Organizational inertia

- QA department is not yet interacting with OSS community
  - Some companies still working to have their software teams learn to interact with OSS communities
- There's a learning curve going from using to contributing
- Testing has not historically been an open activity
  - Concern that tests reveal product info prematurely

Licensing

- License may not require sharing
- Requirement to publish is not invoked
  - QA software is not distributed by a company
  - There's no trigger for license publication requirement

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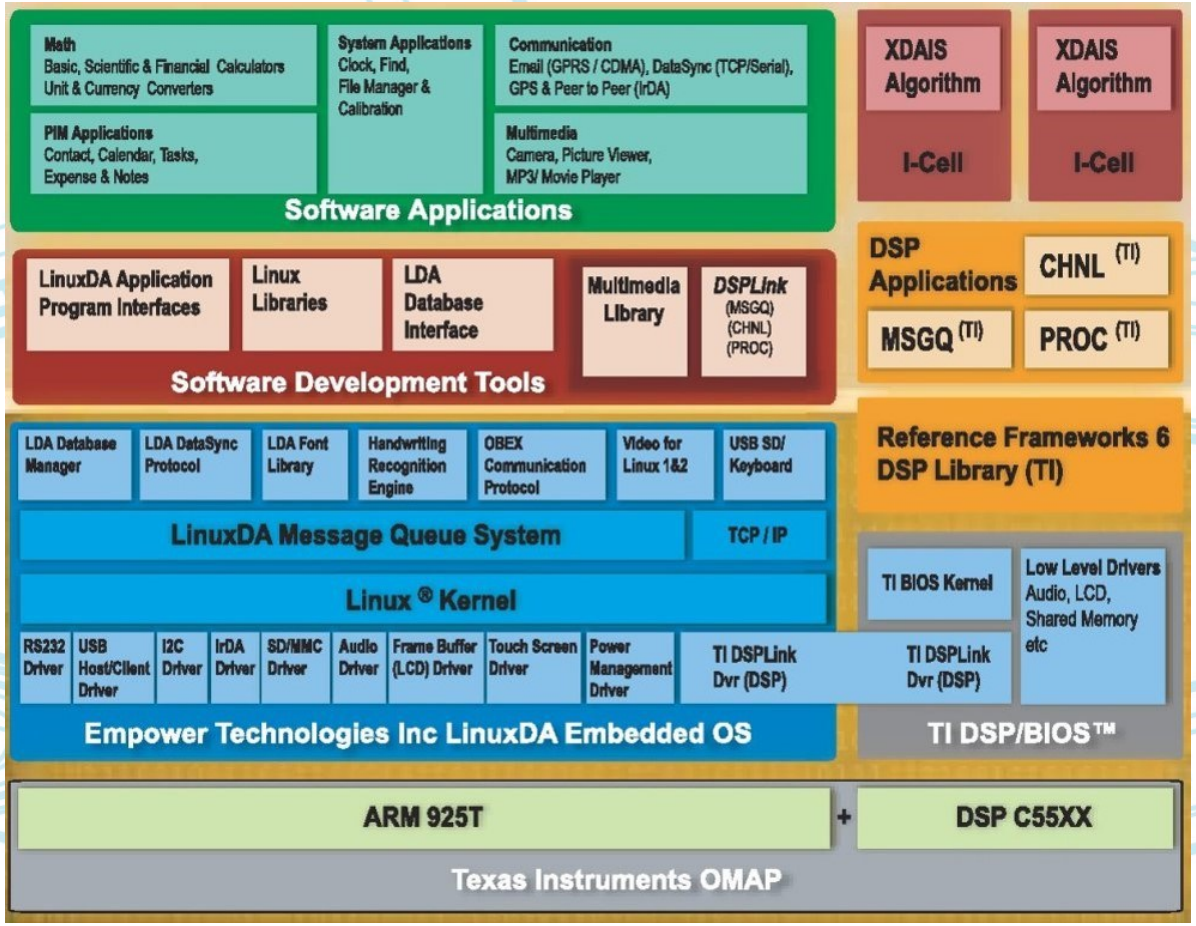
Solutions

- Create objects that can be shared
  - Common CI reference model
  - Standardize test definitions
    - Common APIs
    - Common languages
  - Standardize APIs to lab hardware
- Create places where objects can be shared
- Test generalization
- Interchange

A software stack



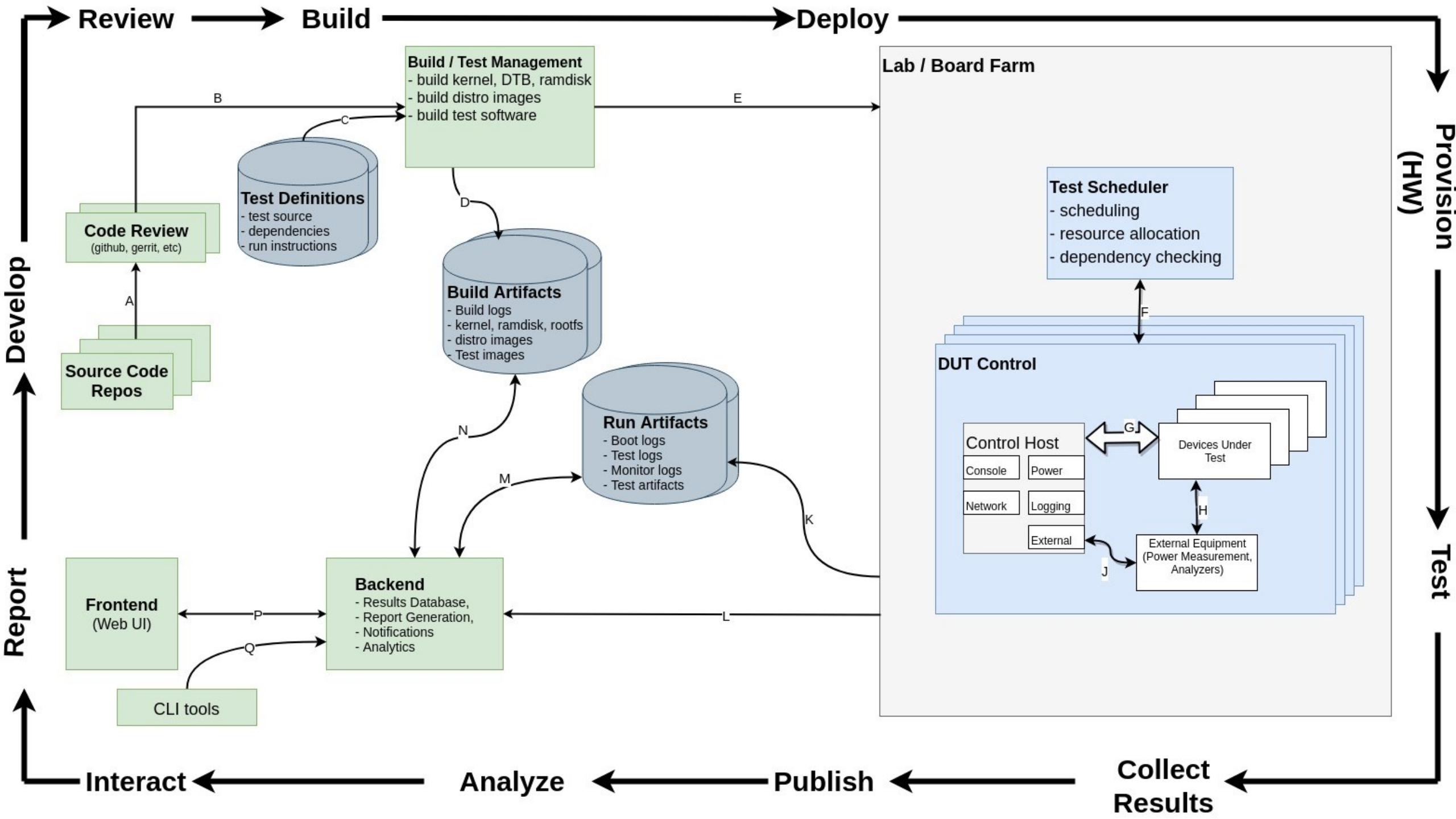
Need similar APIs

Need similar APIs

Need similar APIs

Common CI reference model

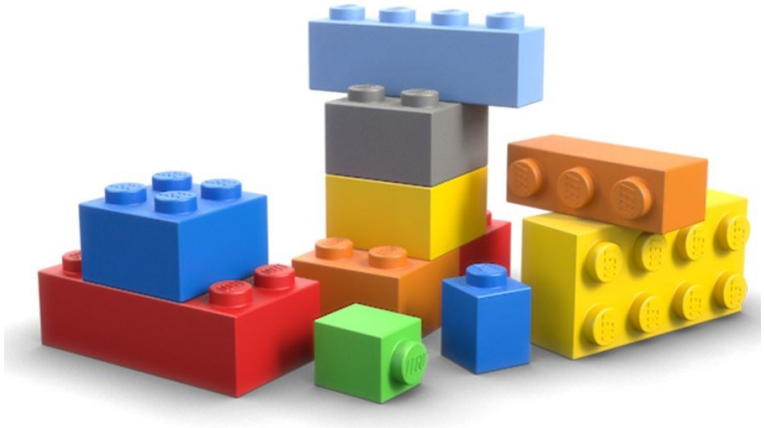
- Like protocol stack
  - Define discrete entities and interfaces
- Organizes operations and responsibilities into layers or modules
- Standard interfaces allow for interchangeable implementations
- At recent Automated Testing Summit, we produced a draft reference model


Review
Build
Deploy
Provision (HW)
Test
Collect Results
Publish
Analyze
Interact
Report
Develop
Build / Test Management
- build kernel, DTB, ramdisk
- build distro images
- build test software
Test Definitions
- test source
- dependencies
- run instructions
Code Review
(github, gerrit, etc)
Source Code Repos
Build Artifacts
- Build logs
- kernel, ramdisk, rootfs
- distro images
- Test images
Run Artifacts
- Boot logs
- Test logs
- Monitor logs
- Test artifacts
Lab / Board Farm
Test Scheduler
- scheduling
- resource allocation
- dependency checking
DUT Control
Control Host
Console
Power
Network
Logging
External
Devices Under Test
External Equipment (Power Measurement, Analyzers)
Backend
- Results Database,
- Report Generation,
- Notifications
- Analytics
Frontend
(Web UI)
CLI tools
A
B
C
D
E
F
G
H
J
K
L
M
N
P
Q

Sharable objects

- Create sharable objects
  - Test definitions usable in multiple frameworks
  - Sharable pass criteria
  - Sharable (mineable) results
    - Common result format

Sharable objects



Test definitions

- Meta-data and instructions for a running a test
- Elements:
  - Pre-requisites and dependencies
  - Information about a test
  - Instructions for test execution
  - Output parsing or conversion
  - Customizations (knobs and dials)
  - Visualization control
- See my presentation later today

Define standards for lab environment

- Board control (power, bus control, multiplexing)
- Multi-machine tests (servers, peers, simulators)
- External hardware (monitors, analyzers)
- API above and below lab controller entities
- Goal is to create ecosystems of plug-and-play modules

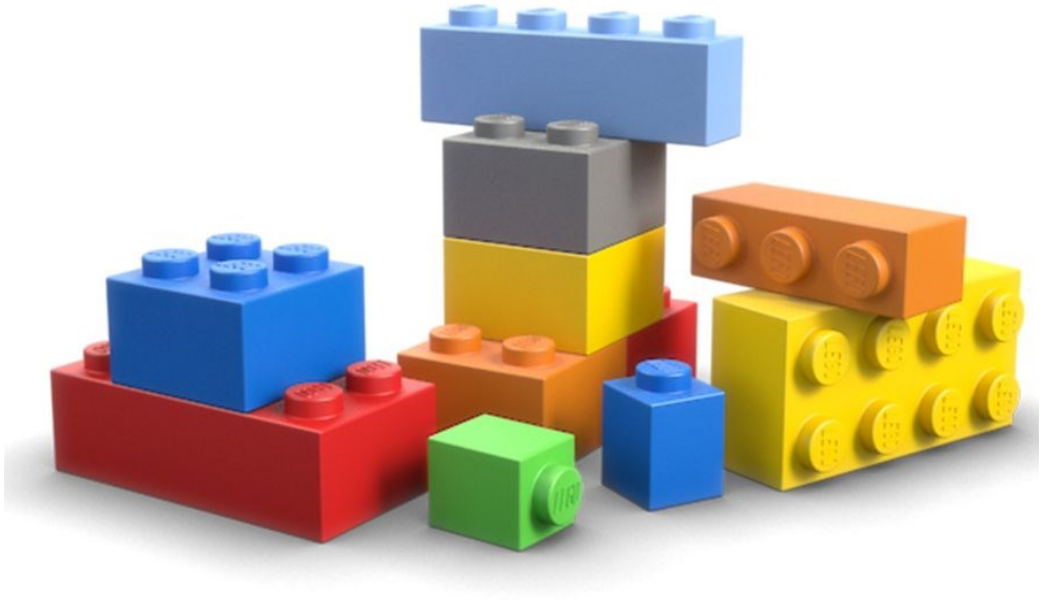
Place to share objects

- Create:
  - Project neutral site for collecting/disseminating objects
  - or...
  - Agreement to consolidate tests in one repository
- Issues:
  - Peer-to-peer test sharing
    - Eliminate gatekeeping for collaboration in testing community
  - Allow ad-hoc test customization and enhancement
    - For diagnosing problems
  - Support diagnosis by remote developer who has hardware needed for test

Test generalization

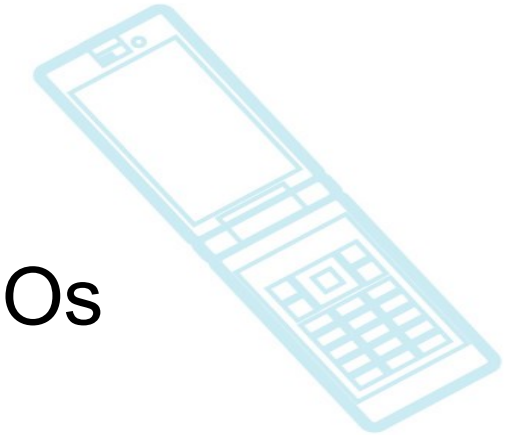
- Allow tests to be generalized
  - by making tests more customizable
- Ways to make a test customizable:
  - Skiplists (control of testcases)
    - Use dependencies to automate
  - Test variables
  - Expected values/Test outcomes (pass criteria)
    - Localized results interpretation
  - Data files for different use cases
    - e.g. filesystem workload - For example, dbench supports custom “loadfiles” which specify the set of operations to perform
- Preferably do automatic customization
  - e.g. Set benchmark value threshold based on previous results

Generalization vs. specialization



Generalization

- Take our pirate pieces, and turn them into LEGOs
  - Or make them compatible with LEGOs

Next steps

- Experimenting
- Creating standards
- Cross-system interactions
- More face-to-face meetings

Next steps – Standards

- At ATS 2018:
  - Agreed to use pdudaemon as standard Power controller
    - Is the first lab API to be standardized
      - Need to actually document and standardize the API
- Working towards standardizing:
  - Test definition
  - Results definition
  - Backend API – KernelCI vs. Squad

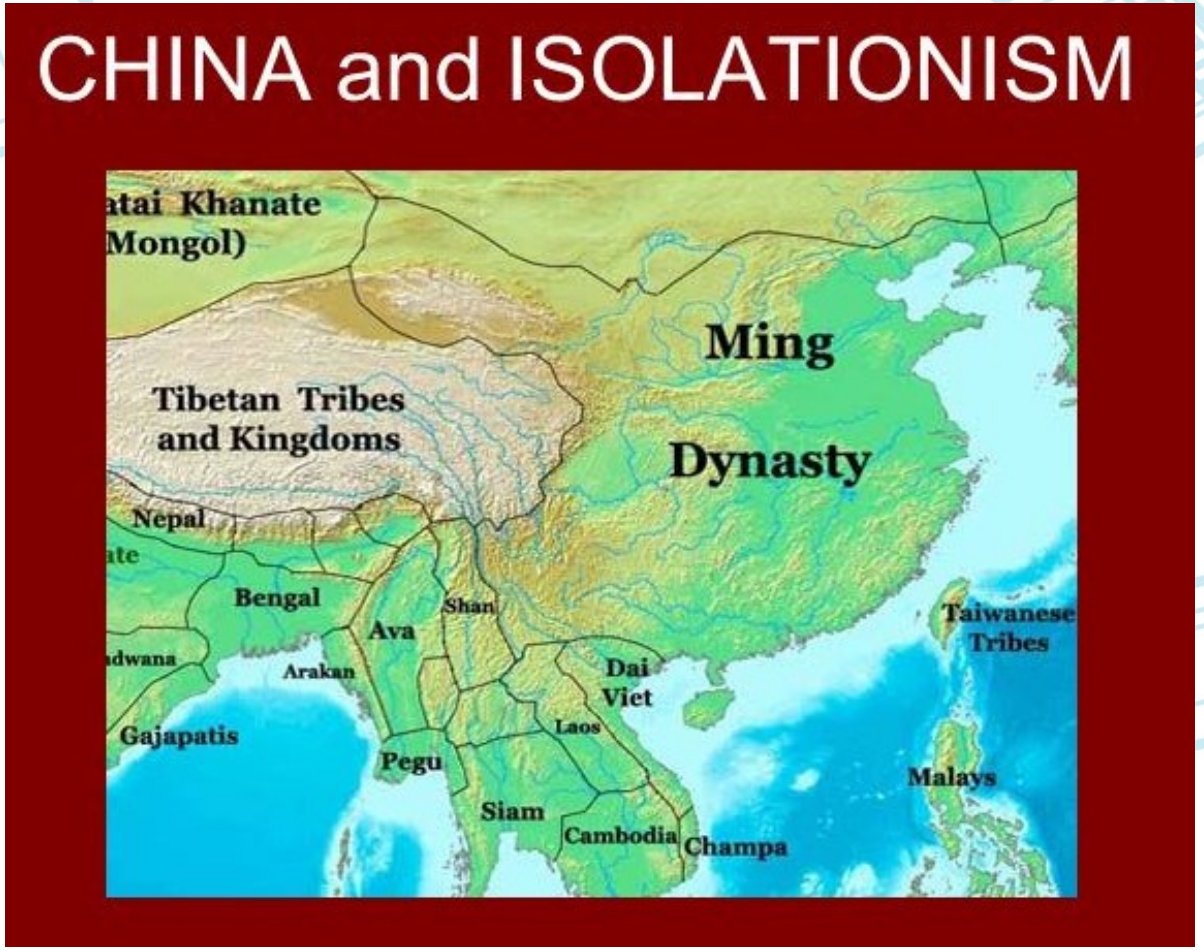
Next steps – Interchange

- Utilize Test Stack Survey
  - See https://elinux.org/Test_Stack_Survey
- Prototype cross-use of results
  - Between Fuego and Linaro projects (LAVA, LKFT, Squad)
    - Unified results format
- Prototype cross-use of tests
  - Between Fuego and Linaro projects
  - Fuego running Linaro tests
  - LAVA running Fuego tests

Next steps – More meetings

- Meetings this week
- Some meeting this fall:
  - Automated Testing Summit #2, or
  - Plumbers Microconference
  - or both

Advice from my Uber driver



Vision – super high level

Do for testing
what open source
has done for coding

Promote the sharing of automated CI components, artifacts, and results, the way code is shared now

- Allow components to specialize
- Support collaboration between projects

TL; DR for the talk...

- Being Open Source is not enough
- Also have to be non-fragmented
- And we have to generalize
  - That is, we have to work together

Let's try to reduce our silos

Image sources

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- china dynasty picture – by Thomas Lessman (http://www.thomaslessman.com/)
- Fire images, sony debug board - by Tim Bird

Thanks

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